U.S. Department of Transportation-approved 55-gallon drums or other suitable temporary containers, and managed as investigation-derived waste (IDW).

2.5 INVESTIGATION-DERIVED WASTE MANAGEMENT

IDW generated during the Fourth Quarter 2016 event consisted of purged groundwater from the monitoring wells and decontamination water. The IDW was handled, stored, and labeled in accordance with Procedure I-A-6, *Investigation-Derived Waste Management* (DON 2015b). Approximately 40 gallons of fluid from all wells were containerized in one, clearly labeled 55-gallon capacity drum, covered with a tarp, and stored on site in an area designated by the Navy. IDW is pending disposal. Disposable personal protective equipment and sampling equipment and supplies were collected in plastic trash bags and disposed of as municipal waste.

3. Data Quality Assessment

A data quality assessment, which consists of a review of the overall groundwater sample collection and analysis process, was performed in order to determine whether the analytical data generated met the quality objectives for the project. The data quality assessment was performed in accordance with the WP/SOW (DON 2016a). The field QC program consisted of standardized sample collection and management procedures, and the collection of field duplicate samples, matrix spike (MS) samples, and trip blank samples. The laboratory QA program consisted of the use of standard analytical methods and the preparation and analyses of MS/MS duplicate (MSD) samples, surrogate spikes, blanks, and laboratory control samples (LCSs)/LCS duplicates (LCSDs).

3.1 GROUNDWATER LEVEL MEASUREMENTS

Depths to groundwater were gauged from the notched and surveyed top of casing using a Solinst oil/water interface probe in wells RHMW01 through RHMW09, OWDFMW01, and HDMW2253-03, and sampling point RHMW2254-01 prior to sampling (Table 3-1). The oil/water interface probe was decontaminated between well measurements by washing with a detergent solution and rinsing with isopropyl alcohol and distilled water to prevent cross contamination. Groundwater elevations beneath the site ranged from 17.67 to 25.08 ft msl. PID readings at the wellheads ranged from 0.0 to 0.8 ppm. No measurable non-aqueous phase liquid (NAPL) was observed during the groundwater sampling event. The October 2016 Oil/Water Interface Measurements letter report submitted to DOH on October 28, 2016, also indicated that no free product was observed in the wells gauged (RHMW01, RHMW02, RHMW03, and RHMW05) on October 19, 2016 (DON 2016c).

Table 3-1: Groundwater Elevations

Monitoring Well Number	Location (relative to tunnel)	Water Level Measurement Date	PID Reading at Wellhead (ppm)	Depth to Water (ft btoc)	Top of Casing Elevation (ft msl)	Groundwater Elevation (ft msl)
RHMW01	Inside	10/17/2016	0.8	83.00	102.41 [a]	19.41
RHMW02	Inside	10/19/2016	0.0	85.69	105.01 [a]	19.32
RHMW03	Inside	10/19/2016	0.0	102.02	121.31 [a]	19.29
RHMW04	Outside	10/25/2016	0.0	293.33	312.57 [a]	19.24
RHMW05	Inside	10/19/2016	0.0	82.37	101.71 [b]	19.34
RHMW06	Outside	10/19/2016	0.0	240.47	259.01 [c]	18.54
RHMW07	Outside	10/19/2016	0.3	197.68	220.29 [c]	22.61
RHMW08	Outside	10/19/2016	0.0	291.94	310.47 [d]	18.53
RHMW09	Outside	10/24/2016	0.0	377.09	394.71 [d]	17.67

Monitoring Well Number	Location (relative to tunnel)	Water Level Measurement Date	PID Reading at Wellhead (ppm)	Depth to Water (ft btoc)	Top of Casing Elevation (ft msl)	Groundwater Elevation (ft msl)
RHMW2254-01	Inside	10/18/2016	0.0	80.68	105.76 [a]	25.08
HDMW2253-03	Outside	10/18/2016	0.0	207.02	226.68 [a]	19.66
OWDFMW-01	Outside	10/20/2016	0.1	119.39	138.57 [a]	19.18

— not recorded
btoc below top of casing
[a] Source: DON 2007.
[b] Source: RHMW05 boring and well completion log, Robert Whittier, TEC Inc. April 24, 2009.
[c] Source: DON 2015a.
[d] Source: AECOM internal Global Positioning System (GPS) survey (July 28, 2016).

3.2 ANALYTICAL RESULTS

The samples were analyzed for TPH-d and TPH-o using U.S. Environmental Protection Agency (EPA) Method 8015C; TPH-g, benzene, toluene, ethylbenzene, and xylenes (BTEX), and 1,2-dichloroethane using EPA Method 8260C; 1,2-dibromoethane using EPA Method 8011; PAHs using EPA Method 8270D SIM; phenol using EPA Method 8270D; and 2-(2-methoxyethoxy)-ethanol using a proprietary laboratory procedure. Copies of the laboratory reports are included as Appendix D. Copies of the third-party data validation reports are included in Appendix E.

Analytical results were compared to the current LTM screening criteria – criteria established by the February 4, 2016, AOC Statement of Work Sections 6 and 7 scoping completion letter (EPA Region 9 and DOH 2016), and updated with the most current DOH Tier 1 EALs in Table D-1b, Groundwater Action Levels (groundwater is a current or potential drinking water resource, and surface water body is not located within 150m of release site) (DOH 2016a) where appropriate. The results of the Fourth Quarter 2016 groundwater sampling event are summarized in Table 3-2, and QC sample results are presented in Table 3-3. In general, COPCs were not detected in most of the outside-tunnel wells and in RHMW05 and RHMW2254-01. However, TPH-d, TPH-o, 1-methylnapthalene, and naphthalene remain above screening criteria in at least one of the following monitoring wells: RHMW01, RHMW02, and OWDFMW01. Figure 2 presents detections and exceedances in COPC concentrations, and Figure 3 presents the natural attenuation parameter (NAP) results at all wells; TPH-d and TPH-o results are included for reference. A cumulative groundwater COPC table containing analytical chemistry results from the beginning of the LTM program is presented in Appendix C. A description of laboratory data qualifiers, definitions of the terms detection limit (DL), limit of detection (LOD), and limit of quantitation (LOQ), and basic concepts of those terms are presented in the Fact Sheet included as Appendix F.

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Table 3-2: Groundwater Sample Results

				Sample ID	ERH088	ERH092	ERH090	ERH091	ERH093	ERH096	ERH089	ERH097	ERH098	ERH102	ERH103	ERH104	ERH105	ERH095
				Location	RHMW2254-01	RHMW2254-01	RHMW01	RHMW02	RHMW03	RHMW04	RHMW05	RHMW06	RHMW07	RHMW08	RHMW09	OWDFMW01	OWDFMW01	HDMW2253-03
				Collection Date	10/18/2016	10/18/2016	10/17/2016	10/19/2016	10/19/2016	10/25/2016	10/19/2016	10/19/2016	10/19/2016	10/19/2016	10/25/2016	10/20/2016	10/20/2016	10/18/2016
				Sample Type	N	FD	N	N	N	N	N	N	N	N	N	N	FD	N
				Field Duplicate Parent Sample	NA	ERH088	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ERH104	NA
Analyte	CAS No.	Method	Screening Criteria	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
TPH-Gasoline Range C6-C10	-3534	8260B	100	µg/L	< 18.0 UJ	< 18.0 U	< 18.0 U	35	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U
TPH-Diesel Range	-3527	8015B_E	100	µg/L	< 25.00 U	< 25.00 U	***120***	***1300***	65	< 25.00 U	< 25.00 U	< 25.00 U	< 25.00 U	< 25.00 U	< 25.00 U	54	< 25.00 U	< 25.00 U
TPH-Diesel Range w/ Silica Gel Cleanup	-3527	8015B_E	100	µg/L	NA	NA	< 25.00 U	***300***	< 25.00 U	NA	< 25.00 U	NA	NA	NA	NA	NA	NA	NA
TPH-Oil Range	-3528	8015B_E	100	µg/L	< 40.00 U	< 40.00 U	< 40.00 U	< 40.00 U	59	< 40.00 U	< 40.00 U	< 40.00 U	< 40.00 U	< 40.00 U	< 40.00 U	***110***	< 40.00 U	< 40.00 U
TPH-Oil Range w/ Silica Gel Cleanup	-3528	8015B_E	100	µg/L	NA	NA	< 40.00 U	< 40.00 U	< 40.00 U	NA	< 40.00 U	NA	NA	NA	NA	NA	NA	NA
Benzene	71-43-2	8260B	5.0	µg/L	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U
Ethylbenzene	100-41-4	8260B	30	µg/L	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U
Toluene	108-88-3	8260B	40	µg/L	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U
Xylenes, Total	1330-20-7	8260B	20	µg/L	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U
1-Methylnaphthalene	90-12-0	8270D_SIM	4.7	µg/L	< 0.10 U	< 0.10 U	< 0.10 U	***25***	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U
2-Methylnaphthalene	91-57-6	8270D_SIM	10	µg/L	< 0.10 U	< 0.10 U	< 0.10 U	9.2	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U
Naphthalene	91-20-3	8270D_SIM	17	µg/L	< 0.10 U	< 0.10 U	< 0.10 U	***49***	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U
1,2-Dibromoethane	106-93-4	8011	0.04	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 0.020 U	< 0.020 U	NA	NA	NA
1,2-Dichloroethane	107-06-2	8260B	5.0	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 0.30 U	< 0.30 U	NA	NA	NA
2-(2-Methoxyethoxy)-Ethanol	111-77-3	8270D	800	µg/L	< 80.0 UJ	< 80.0 UJ	< 80.0 UJ	< 80.0 UJ	< 80.0 UJ	< 80.0 U	< 80.0 UJ	< 80.0 UJ	< 80.0 UJ	< 80.0 UJ	< 80.0 U	< 80.0 U	< 80.0 U	< 80.0 UJ
Phenol	108-95-2	8270D	5.0	µg/L	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U	< 4.00 U
Dissolved Oxygen	NA	FIELD	NA	mg/L	6.79	NA	10	0.61	0.84	6.37	8.36	4.3	1.4	4.71	6.1	3.2	NA	0.39
Oxygen Reduction Potential	NA	FIELD	NA	mV	144	NA	-112	-119	83	113	99	45	30	-8	96	79	NA	-54
Methane	74-82-8	RSK-175	NA	µg/L	< 1.00 U	NA	840	47000	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U	NA	< 1.00 U
Chloride	16887-00-6	300.0	NA	mg/L	72.7	NA	38.7	38.0	46.4	70.8	153	371	414	152	50.5	1020	NA	90.5
Nitrate	14797-55-8	300.0	NA	mg/L	3.0 J	NA	0.45 J	0.43 J	5.7 J	2.4	4.3 J	3.0 J	4.2 J	1.6 J	2.2	7.9 J	NA	2.4 J
Sulfate	14808-79-8	300.0	NA	mg/L	16.3	NA	4.4	0.85 J	46.0	9.5	46.0	84.5	70.0	43.0	9.7	326	NA	9.5
Iron, Ferrous	15438-31-0	3500_FE_B	NA	mg/L	0.19 J	NA	0.53 J	2.8	< 0.32 U	< 0.32 U	< 0.32 U	< 0.32 U	< 0.32 U	< 0.32 U	< 0.32 U	< 0.32 U	NA	2.4

Note: ***Bold italics*** indicate analyte exceeds screening criteria.

µg/L = microgram per liter
FD = field duplicate
J = estimated value
mg/L = milligram per liter
mV = millivolt
N = normal sample
NA = not analyzed or not applicable
U = non-detect value (reported as less than the limit of detection [LOD])

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Table 3-3: Field QC Sample Results

					Sample ID	ERH094	ERH099	ERH106	ERH100	ERH101	ERH107	ERH108
					Collection Date	10/17/2016	10/18/2016	10/19/2016	10/20/2016	10/20/2016	10/20/2016	10/25/2016
					Sample Type	TB	TB	TB	EB	FB	TB	TB
Analyte	CAS No.	Method	Screening Criteria	Unit		Result	Result	Result	Result	Result	Result	Result
TPH-Gasoline Range C6-C10	-3534	8260B	100	µg/L		< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U	< 18.0 U
TPH-Diesel Range	-3527	8015B_E	100	µg/L		NA	NA	NA	< 25.00 U	< 25.00 U	NA	NA
TPH-Diesel Range w/ Silica Gel Cleanup	-3527	8015B_E	100	µg/L		NA	NA	NA	NA	NA	NA	NA
TPH-Oil Range	-3528	8015B_E	100	µg/L		NA	NA	NA	< 40.00 U	< 40.00 U	NA	NA
TPH-Oil Range w/ Silica Gel Cleanup	-3528	8015B_E	100	µg/L		NA	NA	NA	NA	NA	NA	NA
Benzene	71-43-2	8260B	5.0	µg/L		< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U
Ethylbenzene	100-41-4	8260B	30	µg/L		< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U
Toluene	108-88-3	8260B	40	µg/L		< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U	< 0.30 U
Xylenes, Total	1330-20-7	8260B	20	µg/L		< 0.30 U	< 0.30 U	0.42 J	< 0.21 U	< 0.25 U	< 0.30 U	< 0.30 U
1-Methylnaphthalene	90-12-0	8270D_SIM	4.7	µg/L		NA	NA	NA	< 0.10 U	< 0.10 U	NA	NA
2-Methylnaphthalene	91-57-6	8270D_SIM	10	µg/L		NA	NA	NA	< 0.10 U	< 0.10 U	NA	NA
Naphthalene	91-20-3	8270D_SIM	17	µg/L		NA	NA	NA	< 0.10 U	< 0.10 U	NA	NA
1,2-Dibromoethane	106-93-4	8011	0.04	µg/L		NA	NA	< 0.020 U	NA	NA	NA	NA
1,2-Dichloroethane	107-06-2	8260B	5.0	µg/L		NA	NA	< 0.30 U	NA	NA	NA	NA
2-(2-Methoxyethoxy)-Ethanol	111-77-3	8270D	800	µg/L		NA	NA	NA	< 80.0 U	< 80.0 U	NA	NA
Phenol	108-95-2	8270D	5.0	µg/L		NA	NA	NA	< 4.00 U	< 4.00 U	NA	NA
Dissolved Oxygen	NA	FIELD	NA	mg/L		NA	NA	NA	NA	NA	NA	NA
Oxygen Reduction Potential	NA	FIELD	NA	mV		NA	NA	NA	NA	NA	NA	NA
Methane	74-82-8	RSK-175	NA	µg/L		< 1.00 U	< 1.00 U	< 1.00 U	NA	NA	< 1.00 U	NA
Chloride	16887-00-6	300.0	NA	mg/L		NA	NA	NA	NA	NA	NA	NA
Nitrate	14797-55-8	300.0	NA	mg/L		NA	NA	NA	NA	NA	NA	NA
Sulfate	14808-79-8	300.0	NA	mg/L		NA	NA	NA	NA	NA	NA	NA
Iron, Ferrous	15438-31-0	3500_FE_B	NA	mg/L		NA	NA	NA	NA	NA	NA	NA

µg/L = microgram per liter

EB = equipment blank (associated with RHMW01, HDMW2253-03, and OWDFMW01)

FB = field blank (associated with RHMW01, HDMW2253-03, and OWDFMW01)

J = estimated value

mg/L = milligram per liter

mV = millivolt

NA = not analyzed or not applicable

TB = trip blank

U = non-detect value (reported as less than the limit of detection [LOD])

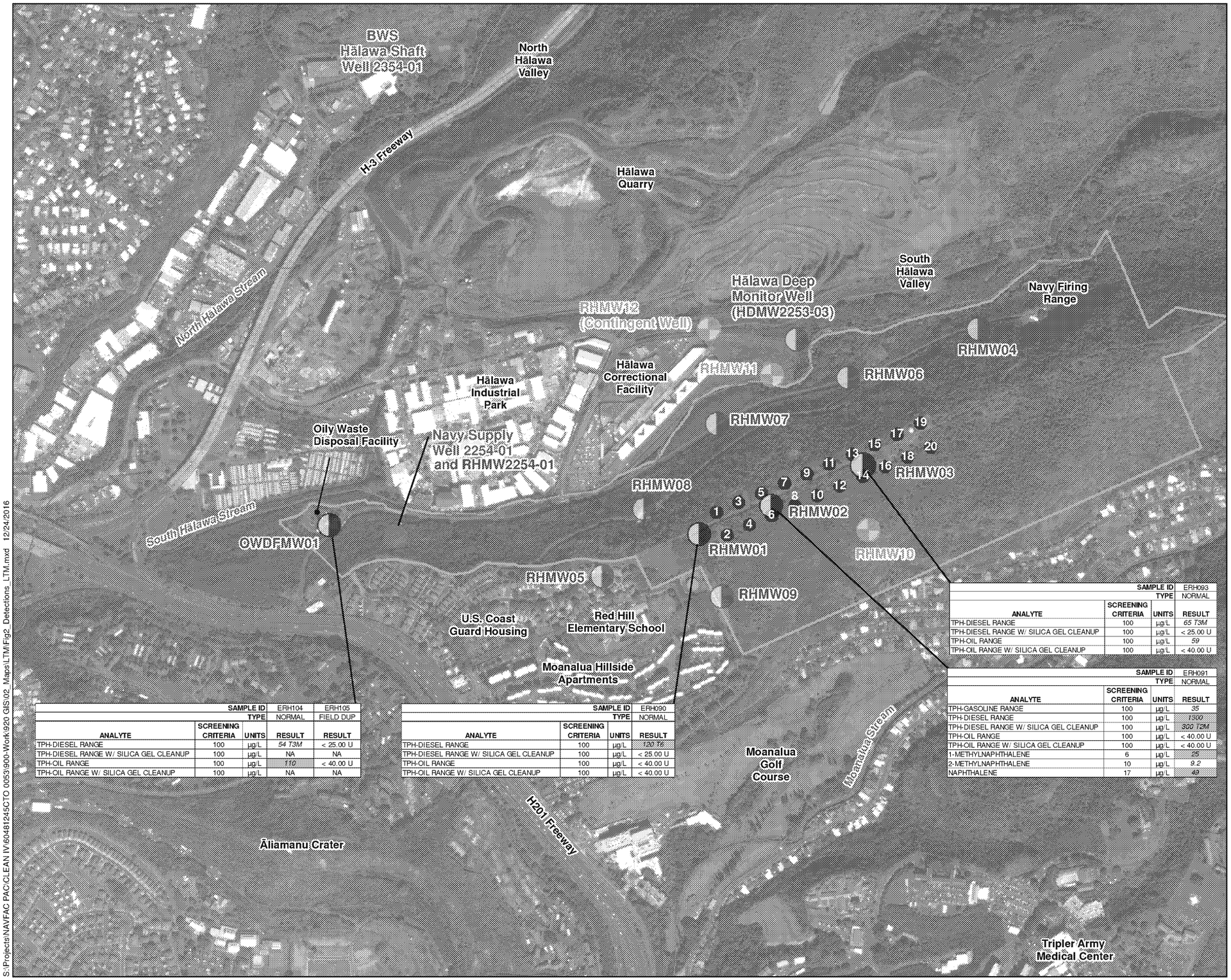
Fourth Quarter 2016 groundwater sampling results are summarized below:

- *RHMW01:* The only analyte detected in groundwater was TPH-d (120 µg/L), which exceeded the screening criterion (100 µg/L), but did not exceed the SSRBL (4,500 µg/L).
- *RHMW02:* Concentrations of TPH-d (1,300 µg/L), silica-gel-cleaned TPH-d (300 µg/L), 1-methylnaphthalene (25 µg/L), and naphthalene (49 µg/L) were detected exceeding their respective screening criteria. The concentrations of TPH-d did not exceed the SSRBL of 4,500 µg/L. Concentrations of TPH-g (35 µg/L) and 2-methylnaphthalene (9.2 µg/L) were also detected, but below their respective screening criteria.
- *RHMW03:* The only analytes detected in groundwater were TPH-d (65 µg/L) and TPH-o (59 µg/L), both below the screening criteria.
- *OWDFMW01:* The only analytes detected in groundwater were TPH-d (54 µg/L for the primary sample, and non-detect in the field duplicate) and TPH-o (110 µg/L for the primary sample and non-detect in the duplicate). The concentration of TPH-o exceeded the screening criterion.

3.3 RECENT GROUNDWATER CONTAMINANT CONCENTRATIONS

The historical groundwater contaminant concentrations for TPH-g, TPH-d, TPH-o, BTEX, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene are illustrated in Appendix G. No graphs were created for lead scavengers, fuel additives, and analytes that have been discontinued and are no longer COPCs for the LTM program. A table of cumulative historical groundwater results is included as Appendix C. Figure 4 and Figure 5 show the TPH and PAH trends, respectively. The summary of groundwater contaminant concentrations provided below focuses on the 2016 groundwater results, before and during the reduced or no pumping status of Navy Supply Well 2254-01 pumps that began in February 2016.

- *RHMW2254-01:* No COPCs were detected in RHMW2254-01 during this quarterly monitoring event, and TPH-d has not been detected since the 1st Quarter 2016 monitoring event. Although the method reporting limits for TPH-d were above the screening criterion in several results prior to August 2010, TPH-d has not been detected in RHMW2254-01 at a concentration above the screening criterion.
- *RHMW01:* TPH-d was the only COPC detected in RHMW01 during this quarterly monitoring event, and groundwater COPC concentrations are declining since the 1st Quarter 2016 monitoring event. TPH-d has historically been detected at concentrations above the screening criterion during most sampling events.
- *RHMW02:* TPH-g, TPH-d, TPH-o, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene have historically been detected at concentrations above the screening criteria. Starting from the 2nd Quarter 2016 event, concentrations of TPH-d decreased to a level below the SSRBL, which was exceeded during quarterly events in 2015 and the 1st Quarter 2016 event. The concentrations of TPH-g, TPH-d, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene are showing a general decline since the 1st Quarter 2016 monitoring event; similarly, TPH-o, which was historically detected at RHMW02 and at concentrations above screening criteria, was not detected during the Fourth Quarter 2016 event.



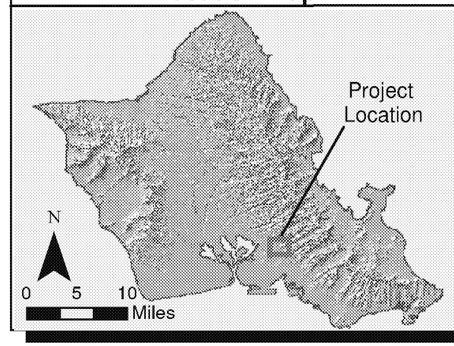
	SAMPLE ID	ERH104	ERH105
	TYPE	NORMAL	FIELD DUP
ANALYTE	SCREENING CRITERIA / UNITS	RESULT	RESULT
TPH-DIESEL RANGE	100 µg/L	*54 T3M*	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100 µg/L	NA	NA
TPH-OIL RANGE	100 µg/L	*110*	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100 µg/L	NA	NA

	SAMPLE ID	ERH090
	TYPE	NORMAL
ANALYTE	SCREENING CRITERIA / UNITS	RESULT
TPH-DIESEL RANGE	100 µg/L	*120 T6*
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100 µg/L	< 25.00 U
TPH-OIL RANGE	100 µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100 µg/L	< 40.00 U

	SAMPLE ID	ERH093
	TYPE	NORMAL
ANALYTE	SCREENING CRITERIA / UNITS	RESULT
TPH-DIESEL RANGE	100 µg/L	*65 T3M*
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100 µg/L	< 25.00 U
TPH-OIL RANGE	100 µg/L	*59*
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100 µg/L	< 40.00 U

	SAMPLE ID	ERH091
	TYPE	NORMAL
ANALYTE	SCREENING CRITERIA / UNITS	RESULT
TPH-GASOLINE RANGE	100 µg/L	*35*
TPH-DIESEL RANGE	100 µg/L	*1300*
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100 µg/L	*300 T2M*
TPH-OIL RANGE	100 µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100 µg/L	< 40.00 U
1-METHYLNAPHTHALENE	6 µg/L	*25*
2-METHYLNAPHTHALENE	10 µg/L	*9.2*
NAPHTHALENE	17 µg/L	*49*

Location Map



Legend

- Monitoring Well with Screening Criteria Exceedances
- Existing Monitoring Well Location
- Existing Water Supply Sampling Point
- Future Monitoring Well Location
- Red Hill Tank
- Stream
- Red Hill Installation Boundary

Notes

1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Installation of monitoring well RHMW12 is contingent pending subsurface conditions. encountered during installation of RHMW11.

ABBREVIATIONS:

- T2M laboratory qualifier indicating chromatogram is mainly lower boiling hydrocarbons (i.e., mineral spirits, kerosene, stoddard solvent, white gas)
- T3M laboratory qualifier indicating chromatogram is mainly higher boiling hydrocarbons (i.e., asphaltene, waste oil, motor oil, or weathered diesel fuel)
- T6 laboratory qualifier indicating chromatogram is mainly a match to hydrocarbons within range of diesel fuel
- U non-detect value (reported as less than the limit of detection [LOD])
- µg/L microgram per liter

1300 Exceeds screening criteria

N

0 400 800 1,600 Feet

Figure 2
COPC Detections
4th Qtr 2016 Groundwater LTM Report
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

S:\Projects\NAVFAC PAC\CLEAN IV\60481245CTO 0053\900-Work\920 GIS\02_Maps\LTM\Fig2_Detections_LTM.mxd 12/24/2016

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ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH098 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	414
NITRATE	NA	mg/L	4.2
SULFATE	NA	mg/L	70
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	1.4
OXYGEN REDUCTION POTENTIAL	NA	mV	30

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH095 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	90.5
NITRATE	NA	mg/L	2.4
SULFATE	NA	mg/L	9.5
IRON, FERROUS	NA	mg/L	2.4
DISSOLVED OXYGEN	NA	mg/L	0.39
OXYGEN REDUCTION POTENTIAL	NA	mV	-54

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH096 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	70.8
NITRATE	NA	mg/L	2.4
SULFATE	NA	mg/L	9.5
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	6.37
OXYGEN REDUCTION POTENTIAL	NA	mV	113

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH088 TYPE: NORMAL RESULT	SAMPLE ID: ERH092 TYPE: FIELD DUP RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA	NA
METHANE	NA	µg/L	< 1.00 U	NA
CHLORIDE	NA	mg/L	72.7	NA
NITRATE	NA	mg/L	3	NA
SULFATE	NA	mg/L	18.3	NA
IRON, FERROUS	NA	mg/L	0.19 J	NA
DISSOLVED OXYGEN	NA	mg/L	6.79	NA
OXYGEN REDUCTION POTENTIAL	NA	mV	144	NA

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH104 TYPE: NORMAL RESULT	ERH105 TYPE: FIELD DUP RESULT
TPH-DIESEL RANGE	100	µg/L	54 T3M	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA	NA
TPH-OIL RANGE	100	µg/L	110	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA	NA
METHANE	NA	µg/L	< 1.00 U	NA
CHLORIDE	NA	mg/L	1020	NA
NITRATE	NA	mg/L	7.9	NA
SULFATE	NA	mg/L	326	NA
IRON, FERROUS	NA	mg/L	< 0.32 U	NA
DISSOLVED OXYGEN	NA	mg/L	3.2	NA
OXYGEN REDUCTION POTENTIAL	NA	mV	79	NA

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH097 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	371
NITRATE	NA	mg/L	3
SULFATE	NA	mg/L	84.5
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	4.3
OXYGEN REDUCTION POTENTIAL	NA	mV	45

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH102 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	152
NITRATE	NA	mg/L	1.6
SULFATE	NA	mg/L	43
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	4.71
OXYGEN REDUCTION POTENTIAL	NA	mV	-8

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH093 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	65 T3M
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 25.00 U
TPH-OIL RANGE	100	µg/L	59
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 40.00 U
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	46.4
NITRATE	NA	mg/L	5.7
SULFATE	NA	mg/L	46
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	0.84
OXYGEN REDUCTION POTENTIAL	NA	mV	83

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH089 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 25.00 U
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 40.00 U
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	153
NITRATE	NA	mg/L	4.3
SULFATE	NA	mg/L	46
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	8.36
OXYGEN REDUCTION POTENTIAL	NA	mV	99

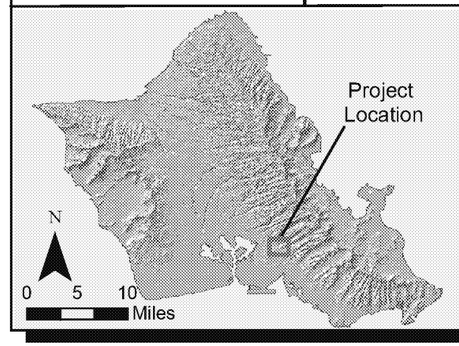
ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH090 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	120 T6
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 25.00 U
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 40.00 U
METHANE	NA	µg/L	840
CHLORIDE	NA	mg/L	38.7
NITRATE	NA	mg/L	0.45 J
SULFATE	NA	mg/L	4.4
IRON, FERROUS	NA	mg/L	0.53 J
DISSOLVED OXYGEN	NA	mg/L	10
OXYGEN REDUCTION POTENTIAL	NA	mV	-112

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH103 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	< 25.00 U
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	NA
METHANE	NA	µg/L	< 1.00 U
CHLORIDE	NA	mg/L	50.5
NITRATE	NA	mg/L	2.2
SULFATE	NA	mg/L	9.7
IRON, FERROUS	NA	mg/L	< 0.32 U
DISSOLVED OXYGEN	NA	mg/L	6.1
OXYGEN REDUCTION POTENTIAL	NA	mV	96

ANALYTE	SCREENING CRITERIA	UNITS	SAMPLE ID: ERH091 TYPE: NORMAL RESULT
TPH-DIESEL RANGE	100	µg/L	1300
TPH-DIESEL RANGE W/ SILICA GEL CLEANUP	100	µg/L	300 T2M
TPH-OIL RANGE	100	µg/L	< 40.00 U
TPH-OIL RANGE W/ SILICA GEL CLEANUP	100	µg/L	< 40.00 U
METHANE	NA	µg/L	47000
CHLORIDE	NA	mg/L	38
NITRATE	NA	mg/L	0.43 J
SULFATE	NA	mg/L	0.85 J
IRON, FERROUS	NA	mg/L	2.8
DISSOLVED OXYGEN	NA	mg/L	0.61
OXYGEN REDUCTION POTENTIAL	NA	mV	-119

BWS Hālawa Shaft Well 2354-01
H-3 Freeway
Hālawa Quarry
South Hālawa Valley
Hālawa Deep Monitor Well (HDMW2253-03)
Navy Firing Range
RHMW12 (Contingent Well)
RHMW11
RHMW06
RHMW04
Hālawa Industrial Park
Hālawa Correctional Facility
RHMW07
RHMW03
Oily Waste Disposal Facility
RHMW08
RHMW02
Navy Supply Well 2254-01 and RHMW2254-01
South Halawa Stream
OWDFMW01
RHMW01
RHMW10
RHMW05
RHMW09
U.S. Coast Guard Housing
Red Hill Elementary School
Moanalua Hillside Apartments
Moanalua Golf Course
H201 Freeway
Moanalua Stream
Tripler Army Medical Center

Location Map



Legend

- Monitoring Well with Screening Criteria Exceedances
- Existing Monitoring Well Location
- Existing Water Supply Sampling Point
- Future Monitoring Well Location
- Red Hill Tank
- Stream
- Red Hill Installation Boundary

Notes

1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Installation of monitoring well RHMW12 is contingent pending subsurface conditions. encountered during installation of RHMW11.

ABBREVIATIONS:

J estimated value
mg/L milligrams per liter
mV millivolts
NA not analyzed or not applicable
U non-detect value (reported as less than the limit of detection [LOD])
µg/L microgram per liter

1300 Results exceeds screening criteria

N
0 400 800 1,600
Feet

Figure 3
Natural Attenuation Parameter Results
4th Qtr 2016 Groundwater LTM Report
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

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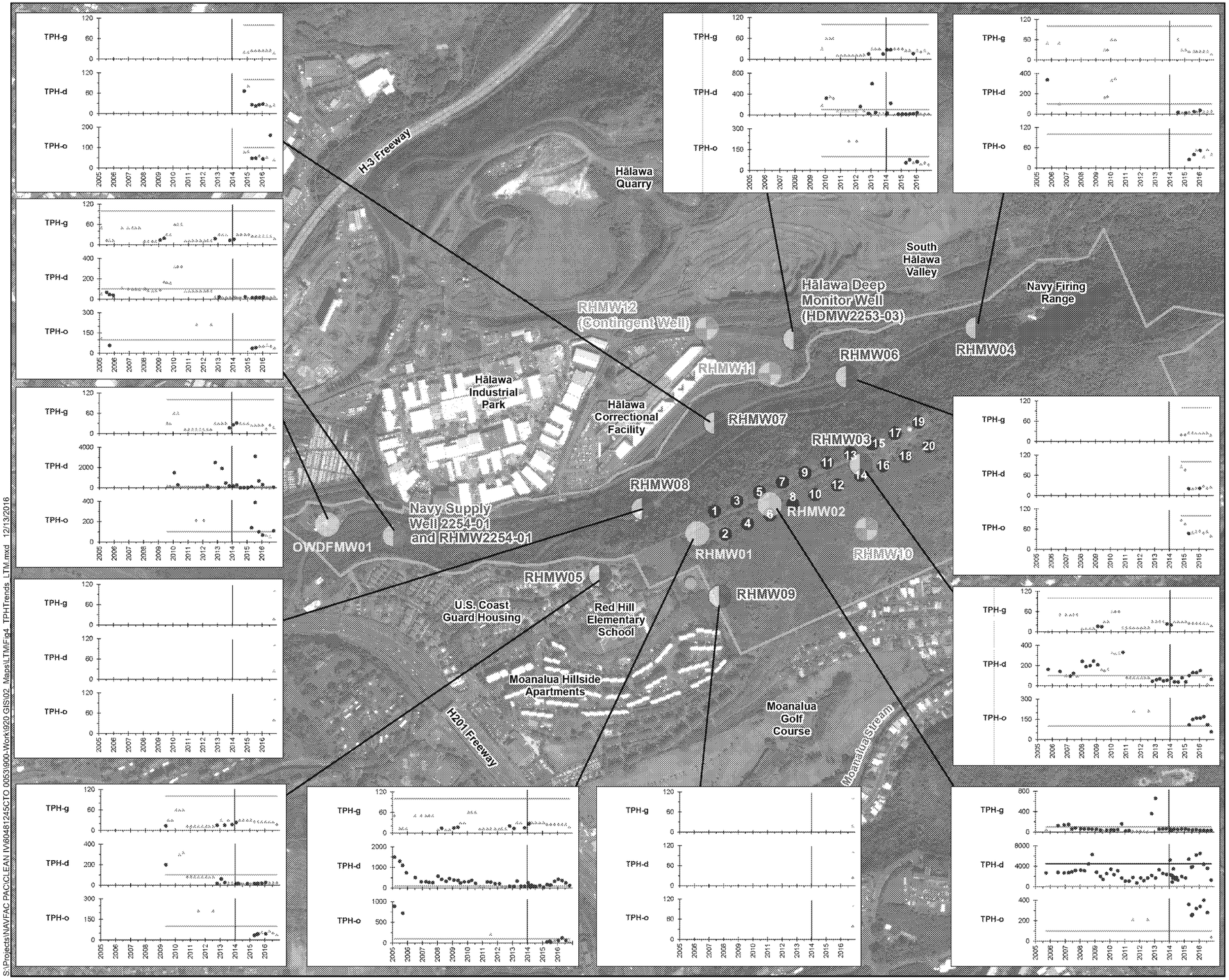
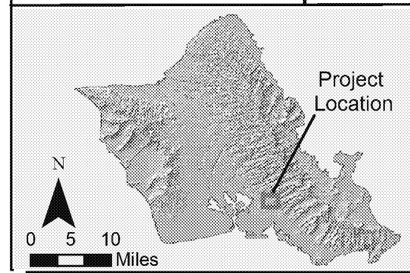


Location Map



Legend

- Groundwater Monitoring Location with Most Recent Results Below Screening Criteria
- Groundwater Monitoring Location at Water Supply Well
- Groundwater Monitoring Location with Most Recent Results Above Screening Criteria
- Future Monitoring Well Location
- Detected Concentration
- Non-Detect Concentration
- Regulatory Screening Level (DOH)
- Site-Specific Risk-Based Level (SSRBL)
- Red Hill Tank
- Stream
- Red Hill Installation Boundary
- 2014 Tank 5 Release

2013 2014 2015

Notes

1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Installation of monitoring well RHMW12 is contingent pending subsurface conditions. encountered during installation of RHMW11.
4. All results in micrograms per liter (µg/L).

N

0 400 800 1,600 Feet

Figure 4
TPH Graphs
4th Qtr 2016 Groundwater LTM Report
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

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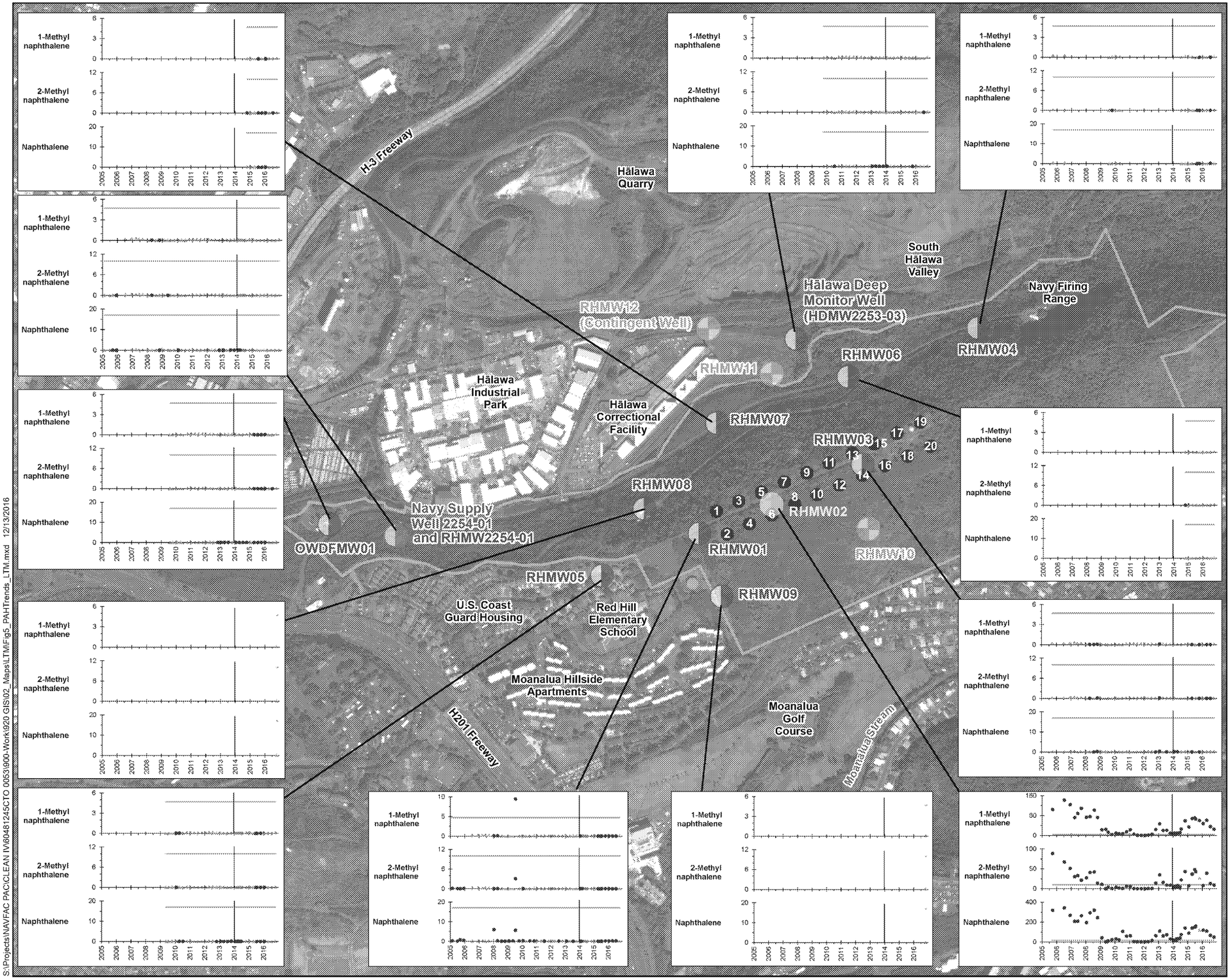
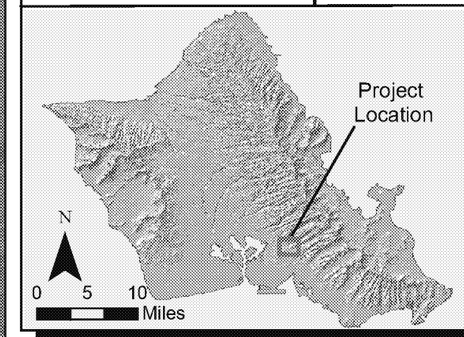


Location Map



Legend

- Groundwater Monitoring Location with Most Recent Results Below Screening Criteria
- Groundwater Monitoring Location at Water Supply Well
- Groundwater Monitoring Location with Most Recent Results Above Screening Criteria
- Future Monitoring Well Location
- Detected Concentration
- Non-Detect Concentration
- Regulatory Screening Level (DOH)
- Red Hill Tank
- Stream
- Red Hill Installation Boundary
- 2014 Tank 5 Release

Notes

1. Map projection: NAD 1983 UTM Zone 4N
2. Base Map: DigitalGlobe, Inc. (DG) and NRCS. Publication_Date: 2015
3. Installation of monitoring well RHMW12 is contingent pending subsurface conditions. encountered during installation of RHMW11.
4. All results in micrograms per liter (µg/L).

N

0 400 800 1,600 Feet

Figure 5
PAH Graphs
4th Qtr 2016 Groundwater LTM Report
Red Hill Bulk Fuel Storage Facility
JBPHH, O'ahu, Hawai'i

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- *RHMW03:* TPH-g, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene detected during this round of quarterly sampling were relatively consistent with the historical data for RHMW03. TPH-d and TPH-o, which have historically been detected at concentrations above the screening criteria, were detected below screening criteria and show a general decline since the 1st Quarter 2016 monitoring event.
- *RHMW04, RHMW05, RHMW06, and HDMW2253-03:* No COPCs were detected during this round of quarterly sampling at these three wells. Several of the COPCs have been detected in previous monitoring events, but the results show that TPH have not been detected after the 1st Quarter 2016 monitoring event.
- *RHMW07:* COPC results during this round of quarterly sampling were generally consistent with the historical data for RHMW07 with the exception of TPH-o from the 3rd Quarter 2016 monitoring event. The unusually high concentration of TPH-o from the 3rd Quarter 2016 event was significantly higher than results for other sampling events. Similar to other wells, most COPCs show no detections since the 1st Quarter 2016 event.
- *RHMW08 and RHMW09:* The Fourth Quarter 2016 groundwater monitoring event is the initial quarterly sampling event for these two newly installed wells. No COPCs were detected, including lead scavengers.
- *OWDFMW01:* TPH-d and TPH-o have periodically been detected significantly above screening criteria since the start of monitoring activities at OWDFMW01 in 2009. The relatively low concentration of TPH-d in the Fourth Quarter 2016 groundwater monitoring event seems consistent with the pattern of very high detections historically followed by sharp declines in concentration in the monitoring events directly after. The concentration of TPH-o, which exceeded the screening criterion in the Fourth Quarter 2016 event also seems consistent with previous results; however, unlike TPH-d, TPH-o has only been consistently analyzed since the 2nd Quarter 2015 groundwater monitoring event.

3.4 DATA VALIDATION AND ASSESSMENT

The analytical laboratory data were submitted to a third-party data validator (Laboratory Data Consultants, Inc.) for data validation and assessment. The objective of data validation is to provide data of known quality for project decisions. Data quality is judged in terms of precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) and performed in accordance with the data validation procedures in the NAVFAC Pacific *Project Procedures Manual* (DON 2015b) and consistent with the protocol in the Department of Defense (DoD) QSM Version 5.0 (DoD 2013). A number of factors may affect the quality of data, including: sample collection methods, sample analysis methods, and adherence to established procedures for sample collection, preservation, management, shipment, and analysis.

Precision

Precision is defined as the reproducibility of replicate measurements. Precision is evaluated by relative percent difference (RPD) of field duplicates, LCS/LCSD, and MS/MSD results. Field duplicate and MS/MSD samples were collected at a rate of approximately 10 percent (%) of primary samples. Field duplicates were sent to the laboratory along with the primary samples.

No volatile organic compounds (VOCs), TPH, PAHs, or fuel additives were detected in the primary and field duplicate samples for RHMW2254-01 (ERH088 and ERH092), thus no RPDs can be calculated for these samples. Only TPH-d and TPH-o (54 µg/L and 110 µg/L, respectively) were detected in the primary sample from OWDFMW01, but these analytes were non-detect in the field

duplicate sample, yielding RPDs at 200% for TPH-d and TPH-o and exceeding the 50% measurement performance criteria. No other precision concerns were identified during validation. Data usability of the field duplicate samples is discussed in Section 3.5.

Accuracy

Accuracy is defined as the degree of conformity of a measurement to a standard or true value. Accuracy is evaluated through measurement of the percent recovery (%R) of an analyte in a reference standard or spiked sample. Accuracy limits for surrogates, laboratory control spike, MS, and MSD samples are either prescribed by the DoD or established by the individual laboratory. The acceptance criteria for accuracy are dependent on the analytical method and are based on historical laboratory or DoD data.

TPH-g from RHMW2254-01 sample ERH088 was reported as non-detect (18 µg/L U), and was qualified as estimated (18 µg/L UJ) during validation due to low MSD %R. Low MSD %R (73.3%, with laboratory acceptance criterion of 78–122%) indicates that the associated TPH-g result from RHMW2254-01 may be biased low for the associated sample (ERH088). No other accuracy concerns were identified during validation. Data usability of the TPH-g results is discussed in Section 3.5.

Representativeness

Representativeness is the degree that data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness was achieved by conducting sampling in accordance with the sample collection procedures described in the project WP/SOW, including standardized sample collection methods identified in Procedure I-C-3, *Monitoring Well Sampling* (DON 2015b).

Representativeness is also evaluated through the compliance with the method-recommended sample holding time and sample preservation methods, and through the analysis of blank samples, including method blank and trip blank samples. For this sampling event, all sample holding times and sample preservation were consistent with EPA SW-846 method recommendations and DoD QSM Version 5.0 (DoD 2013).

All samples were associated with a method blank and trip blank. No COPCs were found in the method blanks and trip blanks with the exception of total xylenes in the trip blank for October 19, 2016. No data were qualified as total xylenes was not detected in any of the samples collected.

For RHMW01, OWDFMW01, and HDMW2253-03, field blank and equipment blanks were collected and analyzed to demonstrate field equipment decontamination efficiency. The only COPC found in the field and equipment blanks was total xylenes, which was qualified as non-detect due to a trip blank detection. No data were qualified as total xylenes was not detected in any of the samples from these locations.

All holding times were met with the exception of the following: 10 of the 16 2-(2-methoxyethoxy)-ethanol results were qualified as estimated due to extraction up to 9 days after the sample collection dates, thus exceeding the 7-day method recommended holding time; and ten of the 12 nitrate results were qualified as estimated due to extraction up to 71.55 hours after the sample collection dates, thus exceeding the 48-hour method recommended holding time. The representativeness of the data is considered acceptable after qualification for holding time. Data usability of the 2-(2-methoxyethoxy)-ethanol and nitrate results is discussed in Section 3.5.

Completeness

Completeness is defined as the overall percentage of valid analytical results (including estimated results) compared to the total number of analytical results reported by the analytical laboratory.

Of the 295 total results reported, none of the results were rejected. The completeness of the data (100%) met the 90% completeness goal.

Comparability

Comparability expresses the confidence with which one data set can be compared to another data set. Comparability can be related to accuracy and precision because these quantities are measures of data reliability. Data with acceptable precision and accuracy are considered comparable if collection techniques, analytical procedures, methods and reporting are equivalent.

All samples collected from October 2010 to February 2015 were analyzed by Calscience Environmental Laboratories in Garden Grove, CA (now Eurofins Calscience). Starting from April 2015, samples were analyzed by ALS Environmental in Kelso, WA. Starting from October 2016, samples were analyzed by APPL in Clovis, CA. Analytical method detection limits (MDLs), limits of detection (LODs), and LOQs for the Fourth Quarter 2016 event were lower for most analytes than they had been during previous events. The method used to analyze TPH-g was changed from 8015 to 8260 to improve sensitivity. The significantly improved reporting limits should be considered when results are compared to data from previous events.

The laboratory used standard analytical methods for all of the analyses. In all cases, the DLs and LODs attained were below the specified LOQs. Target analytes detected below the LOQs flagged (J) by the laboratory should be considered estimated. The comparability of the data is regarded as acceptable.

Sensitivity

The LOQs are established by the laboratory based on the LODs or instrument DLs, historical data, and EPA limits established for the various methods. The LOQs and LODs for samples may require adjustment by the laboratory due to matrix interference or if high levels of target analytes necessitate dilution before analysis. Matrix interference and sample dilutions have the effect of decreasing sensitivity and increasing the LOQs/LODs. No results in this data set have increased LOQs or LODs that have impacted sensitivity and data usability.

3.5 DATA ASSESSMENT AND USABILITY CONCLUSIONS

The PARCCS criteria were evaluated, and with some exceptions, all criteria were met. Results associated with QC data that failed acceptance criteria are discussed in detail in Section 3.4 of this report. Data quality issues that need to be taken into account for project decisions are summarized below.

The 200% RPD for the TPH-d and TPH-o results was caused by non-detect results in one of the field duplicate pair. The field duplicate imprecision for the OWDFMW01 TPH-d and TPH-o results indicate that sampling bias may exist in the collected sample volumes, but that the exact nature of the bias (high or low) cannot be determined due to the nature of the RPD exceedance. Due to the imprecision, there is uncertainty in the true concentration of the TPH-d and TPH-o in OWDFMW01, and whether the TPH-o concentration in the groundwater at OWDFMW01 truly exceeds criteria. The detected values were conservatively used as the OWDFMW01 October 2016 values in the cumulative COPC graphs in Appendix G, and will continue to be used to determine TPH trends for OWDFMW01 and the monitoring network.